This Brief is UNCLASSIFIED

GPS Performance Variational Analysis Results

Presented At:

Performance Analysis Working Group 2000

Presented By:

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Discussion Topics

- Background
- Analysis Approach
- Current GPS Baseline Assessment
- System Performance Variational Analysis Results
- New GPS Performance Standards

Background

- Precision strike a critical element of Joint Vision 2020, but it is expensive
  - ⇨ GPS guided munitions proliferating throughout inventory, but targeting CONOPS not yet mature
  - ⇨ Current real world ops putting tremendous pressure on USSPACE to sustain consistent GPS performance
- Termination of SA has emphasized a burgeoning civil dependency on increasing levels of assured GPS performance
  - ⇨ US DOT pushing DoD for update to SPS Signal Specification -- OSD tasked HQ AF/XOR to respond

BOTTOM LINE: High User Expectations based on Past Performance

Background -- The Current Situation

- Conservative specs coupled with quality engineering has provided extraordinary technical baseline capability, but components aging
- Consistent SPACEAF ops from command and control perspective is driving generally good performance, but users experiencing some transients
- 50th Space Wing 2 SOPS is making increasing use of GPS Support Center global predictions to optimize constellation maintenance -- however, concept not yet institutionalized
- Lack of formal system-level performance metrics making ops resource utilization decisions increasingly difficult, especially as OCS and constellation age

ANALYSIS APPROACH

- Analysis Objectives
- Definition of a Sustainable Performance Standard
- Current System Baseline Definition for Analysis Purposes
- Identification of Performance Degrees-of-Freedom
- Definition of System-level Performance Metrics
- Performance Variational Analysis

Analysis Objectives

- Develop performance metrics for current operations that are consistent with and support evolution to the GPS ORD
- Determine system-level performance being achieved based on current GPS capabilities and operations tempo
- Evaluate range of performance behaviors due to conservative variation of key baseline parameters
- Develop system baseline performance standard values that are sustainable with the current technical and operational baselines

Definition of a Sustainable Standard

- Performance Standard not Valid Unless It Consists Of:

  1) Approved Performance Term Definitions
  2) Quantifiable Metrics
  3) Accountable Thresholds

- Documentation available to support all three elements
- Definition of **accountable thresholds** is focus of this brief

Definition of Current System Baseline

Technical Baseline	Operational Baseline	System Baseline
• Physical Elements of System ⇨ Satellites ⇨ OCS ⇨ PPS UE • Design Specifications • Interface Control Documents • Warranty Requirements • Sustainment • New Capability Development/Integration	• OPSCAP Criteria • CONOPS ⇨ URE Management ⇨ Slot Management ⇨ SV Availability ⇨ Time Management • Maintenance Concept • Unit Manning • Operations Tempo Management ⇨ Normal vs Tactical ⇨ Satellite Disposal ⇨ Launch Callups	• SYSCAP Criteria ⇨ PPS/SPS Accuracy ⇨ PPS/SPS Availability ⇨ Service Reliability • Tactical Support Requirements • Crypto Operations Policies • SA Operations Policies

Performance Degrees-of-Freedom

GPS Ops Controls:

- User Range Error
- Satellite Slots
- Satellite Availability
- Error in Time Bias

ENVIRONMENT

USER APPLICATION

Performance Experienced By Users

Using:

- Uploads, Filter Tuning
- Stationkeeping Maneuvers
- SOH Contacts, Maintenance Supports
- Uploads, Time Management Program in OCS

Given:

- Clock Stability, Ephemeris Predictability, Curve Fit Error
- Orbit Insertion Accuracy, Nominal Slot Definitions
- SV RMA, Warranty Requirements
- UREs, USNO Measurement Process

Performance Metrics

- DoD recently established formal definitions for GPS service availability and accuracy in JROC approved ORD

- Definitions employed in new standard, with slight mods to accommodate current ops

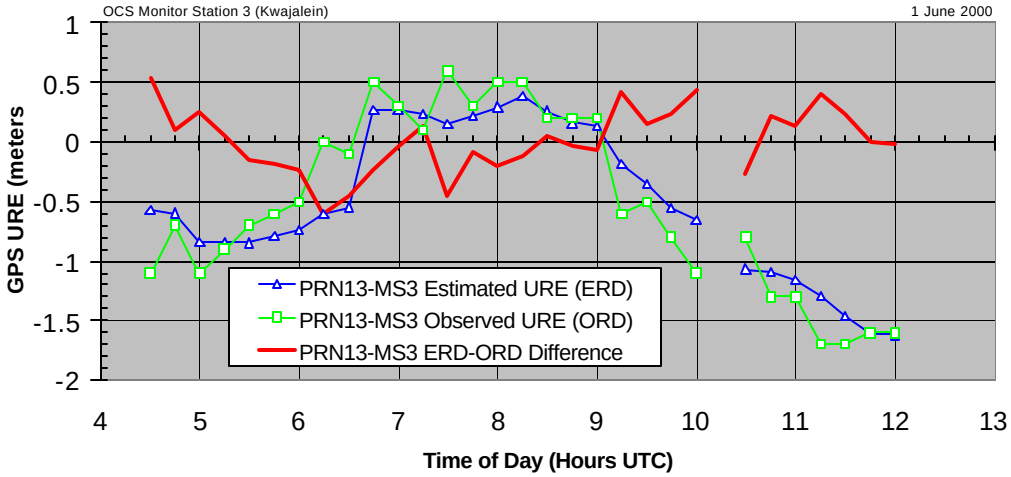
Service Availability: Percentage of time over any 24 hour interval that **predicted** 95% positioning error is less than its threshold, **for any point** within the service volume

Positioning Accuracy: Statistical difference at a 95% probability between **position measurements** and a surveyed benchmark, **for any point** within the service volume, over any 24 hour interval

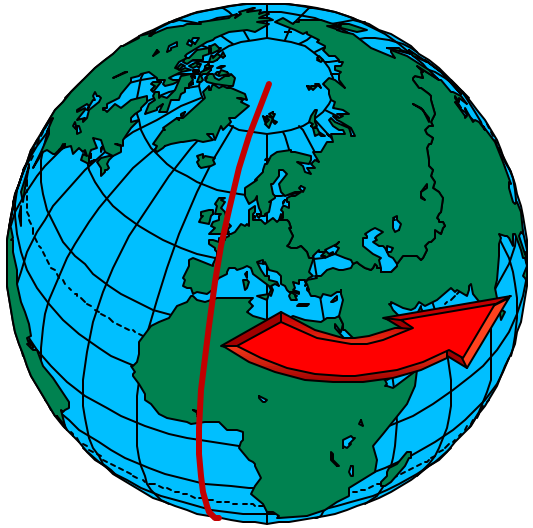
Analytic Process

- MCS log data, almanacs, NANUs
- URE Audit Function
- **Service Availability:** Weighted UNE Algorithm
- **Position Accuracy:** Point NAV Solutions
- **Time Transfer Accuracy:** All-in-View Ensemble
- Overlook's Tactical Tool Suite used for all analyses

Example Audit Between Estimated and Measured UREs



Equidistantly Spaced Global Grid with discrete time steps



Performance Variational Analysis

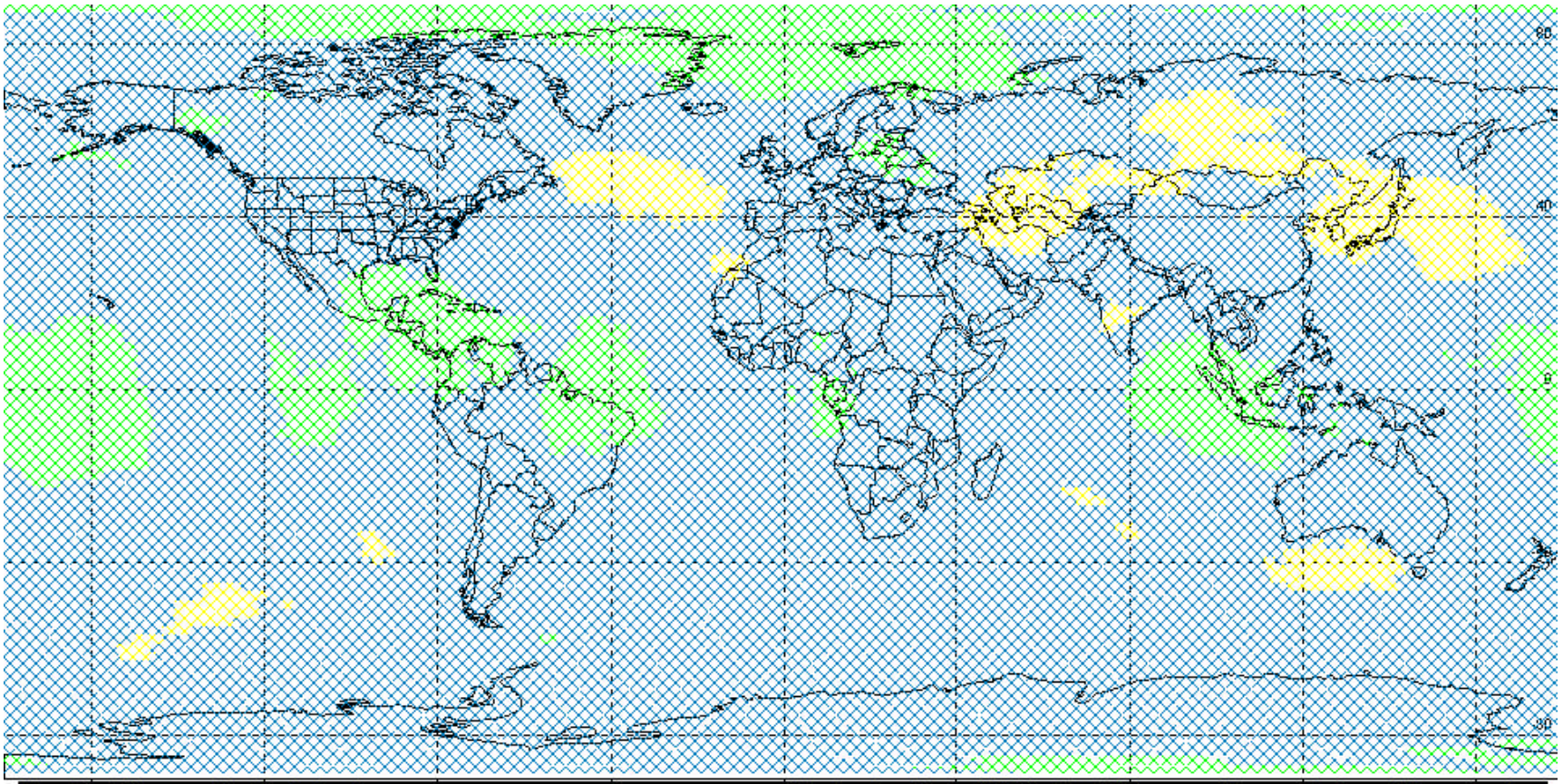
- GROUND RULE: Given current technical baseline, determine performance levels that can be sustained with current ops tempo and resource allocations

- **Task 1:** Baseline Assessment
- **Task 2:** Daily URE Variational Assessment
- **Task 3:** Satellite Slot Tolerance Sensitivity Analysis
- **Task 4:** Satellite Removal Sensitivity Analysis

BASELINE ASSESSMENT

- Current Nominal System Performance
- GPS Technical Baseline Assessment
- GPS Operational Baseline Assessment
- Dynamics of Baseline Interactions

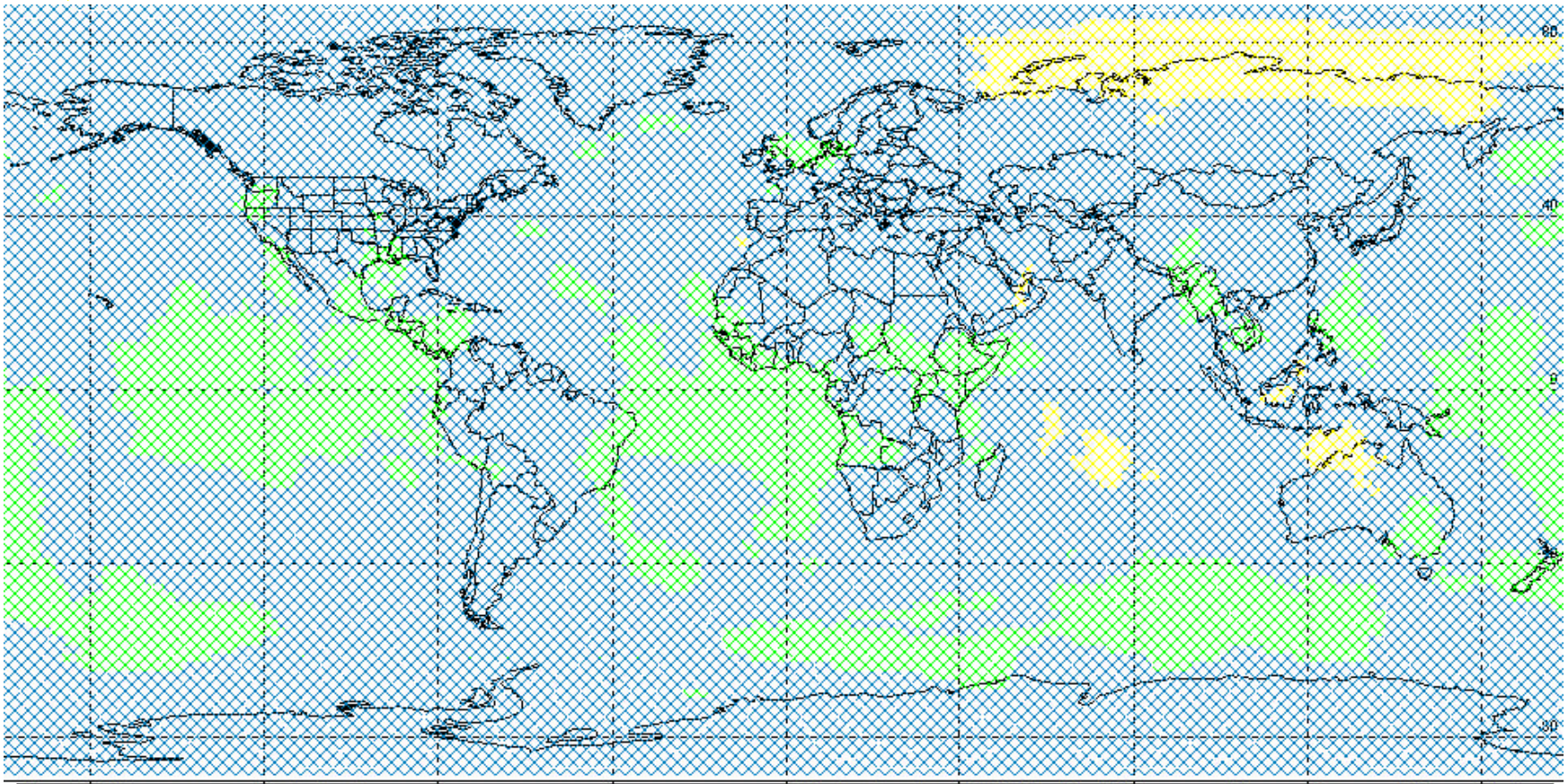
Horizontal 95% Accuracy -- 26 Sept 2000



Overlook Systems Technologies, Inc.		*Production Date: 251528z Oct 2000*	*0-1*		*3-4*
Analysis Start: 260000z Sep 2000	*2SOPS Almanac: 270*	*Metric: Magnitude of HNavError95%*	*1-2*		*4-5*
Analysis Stop: 262400z Sep 2000	*Satellite Selection: AIV*	*Mask Angle: 5 degrees*	*2-3*		*5- >5*
Grid Increment: 2 degrees	*Time Increment: 60 seconds*	*Altitude: 0 meters*			
PRNs Removed	*16*	*18*			
Removal Start	*261200z Sep 2000*	*261200z Sep 2000*			
Removal Stop	*262359z Sep 2000*	*262359z Sep 2000*			

Worst Site: 3.7 Meters 95%

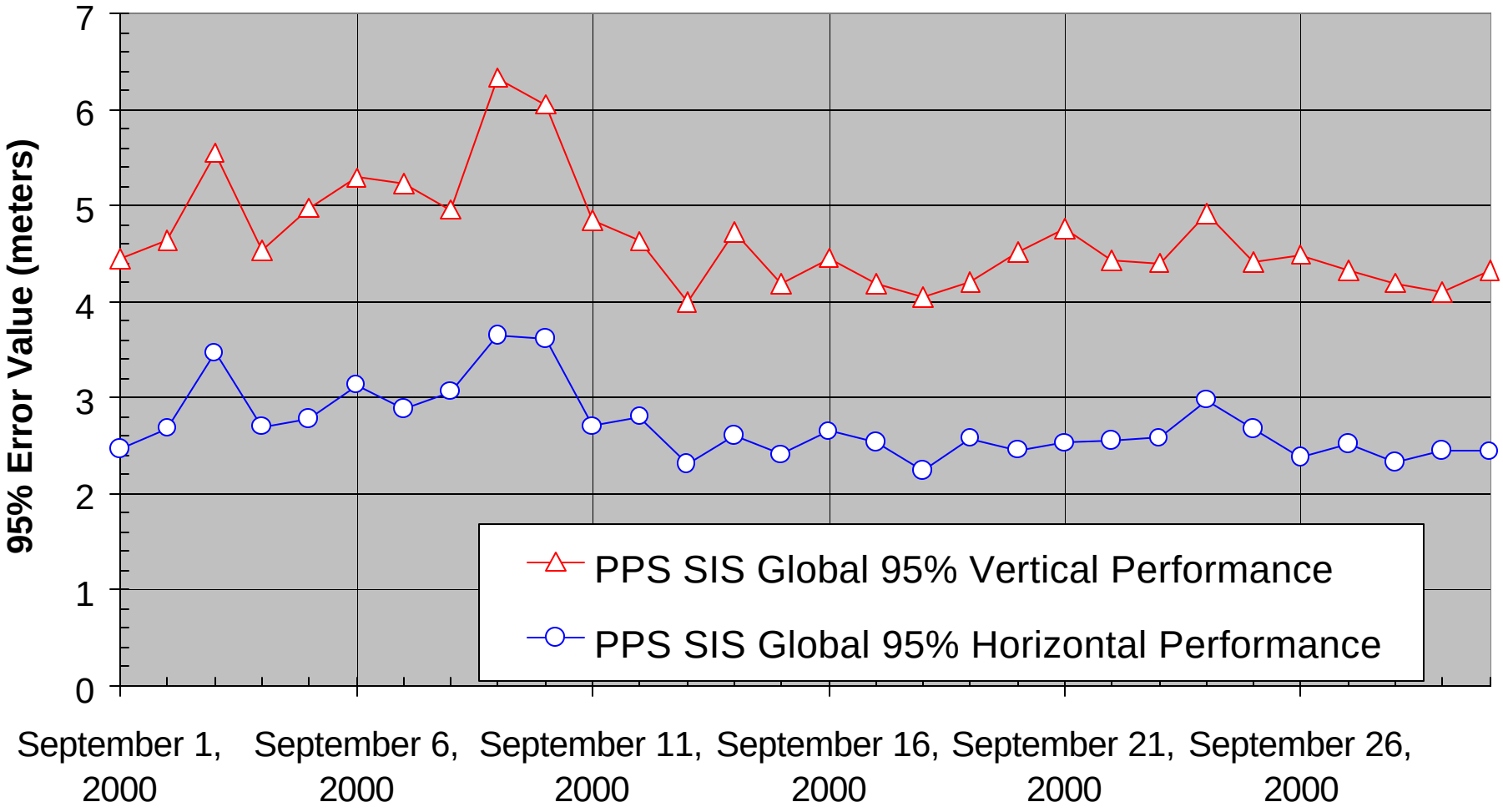
Vertical 95% Accuracy -- 26 Sept 2000



Overlook Systems Technologies, Inc.		Production Date: 251537z Oct 2000	0-2	6-8	
Analysis Start: 260000z Sep 2000	2SOPS Almanac: 270	Metric: Magnitude of VNavError95%	2-4	8-10	
Analysis Stop: 262400z Sep 2000	Satellite Selection: AIV	Mask Angle: 5 degrees	4-6	10- >10	
Grid Increment: 2 degrees	Time Increment: 60 seconds	Altitude: 0 meters			
PRNs Removed	16	18			
Removal Start	261200z Sep 2000	261200z Sep 2000			
Removal Stop	262359z Sep 2000	262359z Sep 2000			

Worst Site: 7.5 Meters 95%

PPS 95% Accuracy -- September 2000



Nominal Performance Summary

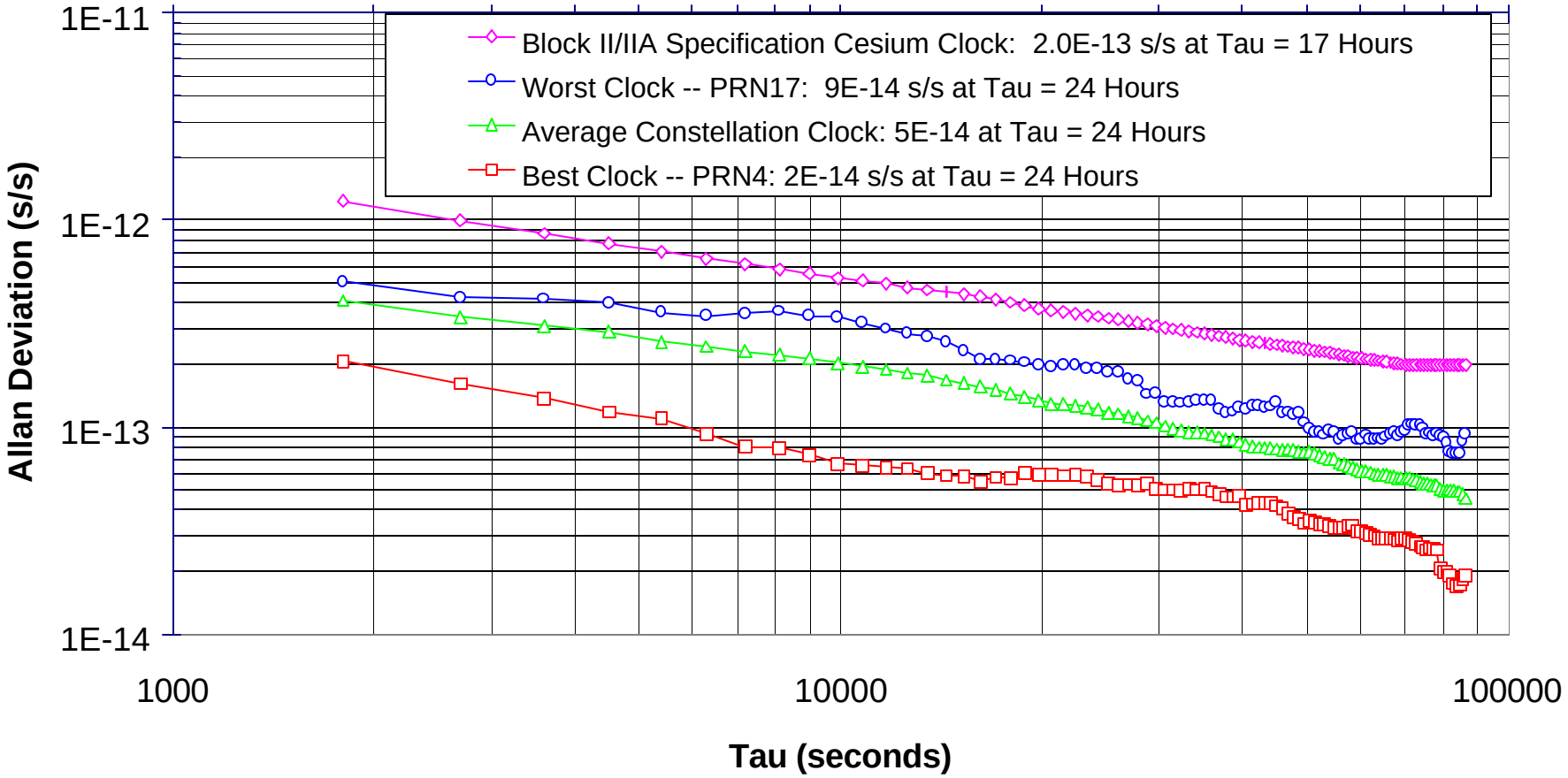
Performance Parameter	Variational Parameter	Grid Spacing	Initial Conditions	Run Results		
				Availability Statistic	**Global Average**	**Worst Site**
Availability	Nominal 24 SV Constellation, PPS SIS Weighted UNE Algorithm	1x1 41,344 Points	• 10-17 June 2000 UREs • No receiver noise • No Iono, Tropo	PPS Horizontal Availability 6.3 meters 95%	99.996%	98.889%
				PPS Vertical Availability 13.6 meters 95%	99.982%	98.611%
Accuracy	Nominal 24 SV Constellation, PPS SIS	1x1 41,344 Points	• 19 June 2000 • No receiver noise • No Iono, Tropo	**Position Error Statistic**	**Global Average**	**Worst Site**
				PPS 50% Horizontal	1.4 m	2.2 m
				PPS 95% Horizontal	**3.2 m**	**5.6 m**
				PPS 50% Vertical	1.8 m	3.0 m
				PPS 95% Vertical	**5.6 m**	**9.5 m**
Availability	Nominal 24 SV Constellation, SPS SIS Weighted UNE Algorithm	1x1 41,344 Points	• 10-17 June 2000 UREs • No receiver noise • C/A-P biases • No Iono, Tropo	**Availability Statistic**	**Global Average**	**Worst Site**
				SPS Horizontal Availability 6.3 meters 95%	99.992%	98.819%
				SPS Vertical Availability 13.6 meters 95%	99.973%	98.542%
Accuracy	Nominal 24 SV Constellation, SPS SIS	1x1 41,344 Points	• 19 June 2000 • No receiver noise • C/A-P biases • No Iono, Tropo	**Position Error Statistic**	**Global Average**	**Worst Site**
				SPS 50% Horizontal	1.5 m	2.2 m
				SPS 95% Horizontal	**3.3 m**	**5.6 m**
				SPS 50% Vertical	1.9 m	3.2 m
				SPS 95% Vertical	**5.6 m**	**9.6 m**

Technical Baseline Assessment

- Satellite Clock Stability
- Ephemeris Predictability
- SPS URE Bias Assessment
- GPS Satellite RMA Attributes
- GPS Constellation Availability
- OCS RMA Attributes

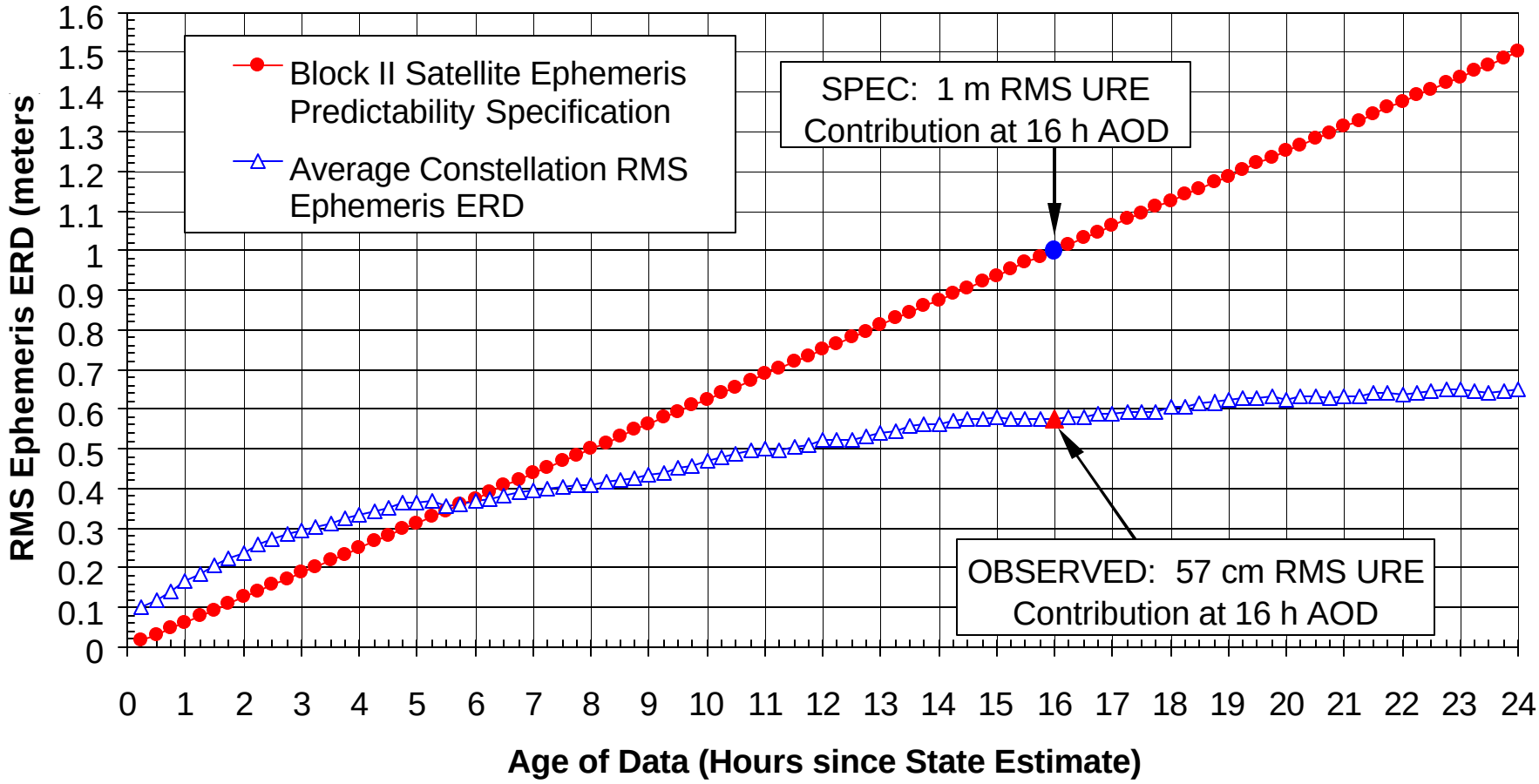
Satellite Clock Stability

Allan Deviation Inferred from OCS Clock Prediction Error
Apparent Best vs. Worst Clocks, June 2000



Ephemeris Predictability

GPS Ephemeris Predictability, June 2000



SPS URE Range Bias Assessment

PRN	Average (m)	High Value (m)	Low Value (m)	Spread (m)	Variance (m^2)
1	-0.105	0.04	-0.23	0.27	0.053
2	-0.347	-0.2	-0.45	0.25	0.05
3	0.011	0.17	-0.08	0.26	0.051
4	0.388	0.53	0.29	0.24	0.051
5	-0.223	-0.07	-0.35	0.28	0.052
6	0.137	0.3	0.03	0.27	0.059
7	-0.376	-0.04	-0.5	0.46	0.077
8	-0.291	-0.13	-0.4	0.26	0.055
9	0.084	0.25	-0.04	0.29	0.061
10	-0.556	-0.41	-0.65	0.24	0.051
13	0.485	0.63	0.4	0.24	0.049
14	0.088	0.23	-0.03	0.27	0.052
15	-0.375	-0.23	-0.48	0.25	0.053
16	-0.26	-0.12	-0.36	0.24	0.051

PRN	Average (m)	High Value (m)	Low Value (m)	Spread (m)	Variance (m^2)
17	-0.329	-0.16	-0.45	0.29	0.066
18	-0.004	0.14	-0.12	0.26	0.057
19	0.085	0.23	-0.02	0.25	0.056
21	-0.14	0.01	-0.24	0.25	0.052
22	-0.48	-0.33	-0.58	0.24	0.052
23	-0.178	-0.05	-0.27	0.22	0.049
24	0.064	0.21	-0.04	0.25	0.052
25	0.215	0.38	0.09	0.29	0.064
26	0.369	0.52	0.28	0.24	0.049
27	-0.033	0.12	-0.16	0.28	0.056
29	0.257	0.4	0.17	0.23	0.051
30	0.498	0.64	0.4	0.24	0.049
31	-0.223	-0.08	-0.32	0.24	0.052

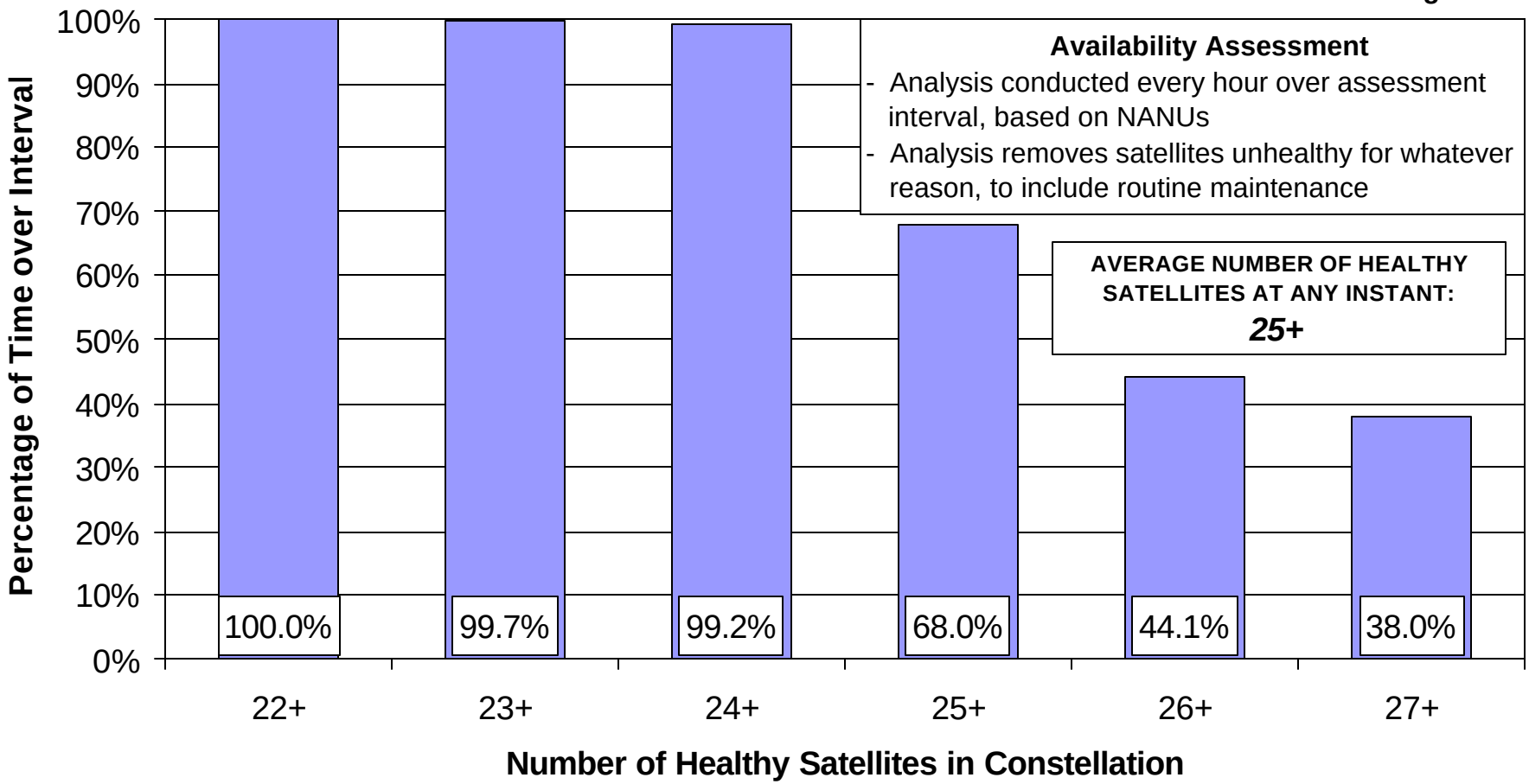
- Data Obtained June 2000 from JPL via Aerospace Corporation
- Periodic updates required to track long-term variation, and whenever a satellite NAV string redundancy configuration is changed

GPS Satellite RMA Attributes

GPS Satellite RMA Parameter: January 1994 – July 2000	Actual	Theoretical/Design
Total Forecast Downtime per SV per year (hrs)	35.6	NA
Total Scheduled Downtime per SV per year (hrs)	18.7	24
Total Unscheduled Downtime per SV per year (hrs)	39.3	64
Total Actual Downtime per SV per Year (hrs)	58.0	88
Satellite MTBF (hrs)	10,749.4	2,346.4
Satellite MTTR (hrs)	48.2	17.1
Satellite MTBDE (hrs)	3,255.9	1,528.8
Satellite MDT (hrs)	21.5	15.4
# Unscheduled Satellite Downing Events per SV per year	0.9	3.7
# Scheduled Satellite Downing Events per SV per year	1.9	2.0
# Total Average Satellite Downing Events per SV per year	2.7	5.7
Average SV Availability per year - Scheduled Downtime	99.79%	99.73%
Average SV Availability per year - All Downtime	**99.34%**	**99.00%**

GPS Constellation Availability

ASSESSMENT INTERVAL: 1 Jan 1995 - 18 Aug 2000



OCS RMA Attributes

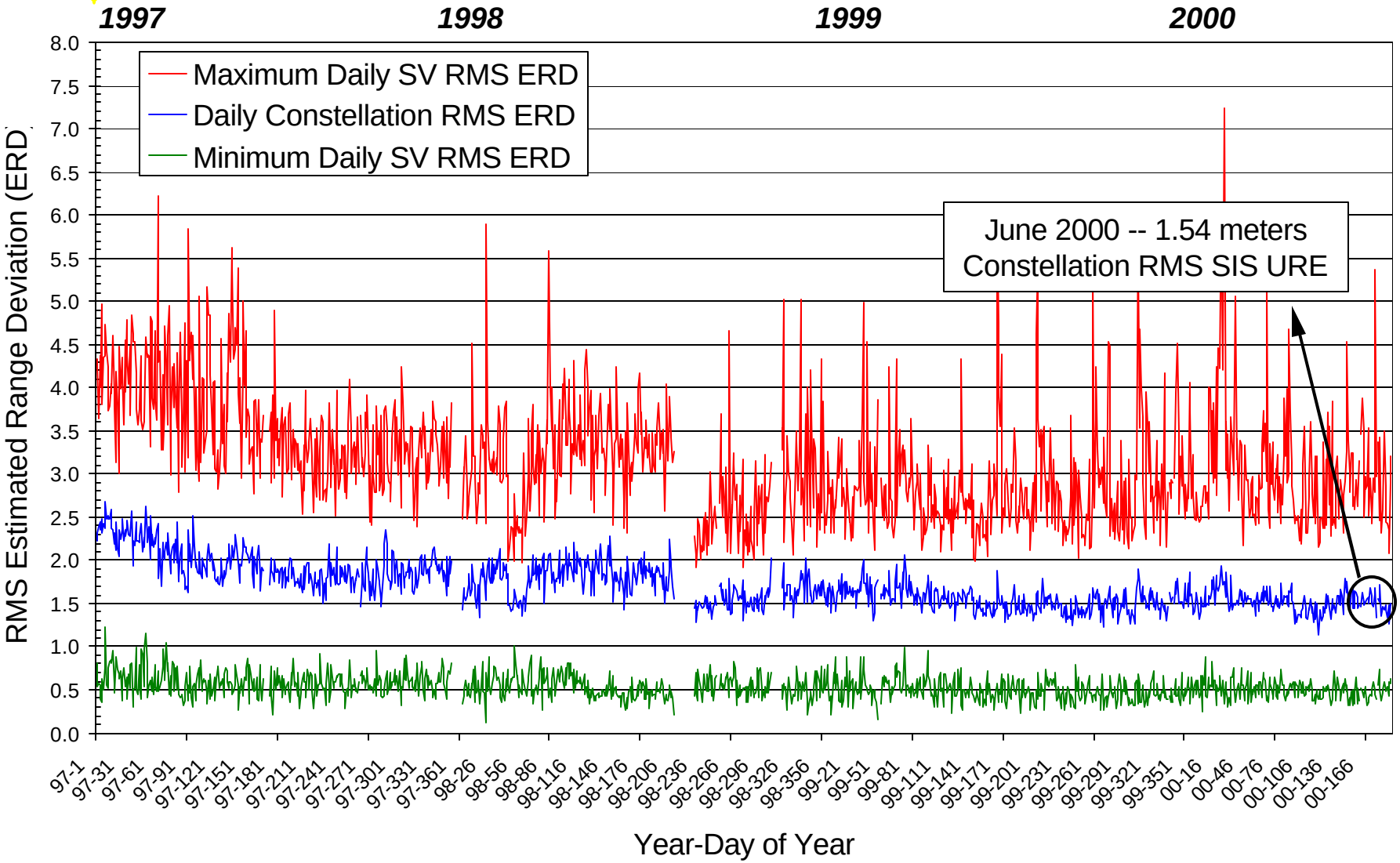
Availability Type	Master Control Station	Ground Antenna Communications	Ground Antenna	System-Level Availability
Inherent Availability	99.60%	99.22%	98.44%	***97.28%***
Achieved Availability	98.62%	99.22%	94.11%	***92.09%***
Operational Availability	98.12%	99.22%	90.34%	***87.95%***

- Operational availability represents availability of an asset or string to support constellation operations
- 85% value used in performance variational analysis to reflect worst case historical period of performance

Operational Baseline Assessment

- GPS SIS PPS User Range Error (URE) Trend
- Constellation Slot Tolerance Management
- Constellation Slot Availability Management
- OCS Loading Assessment

GPS PPS SIS URE Trend

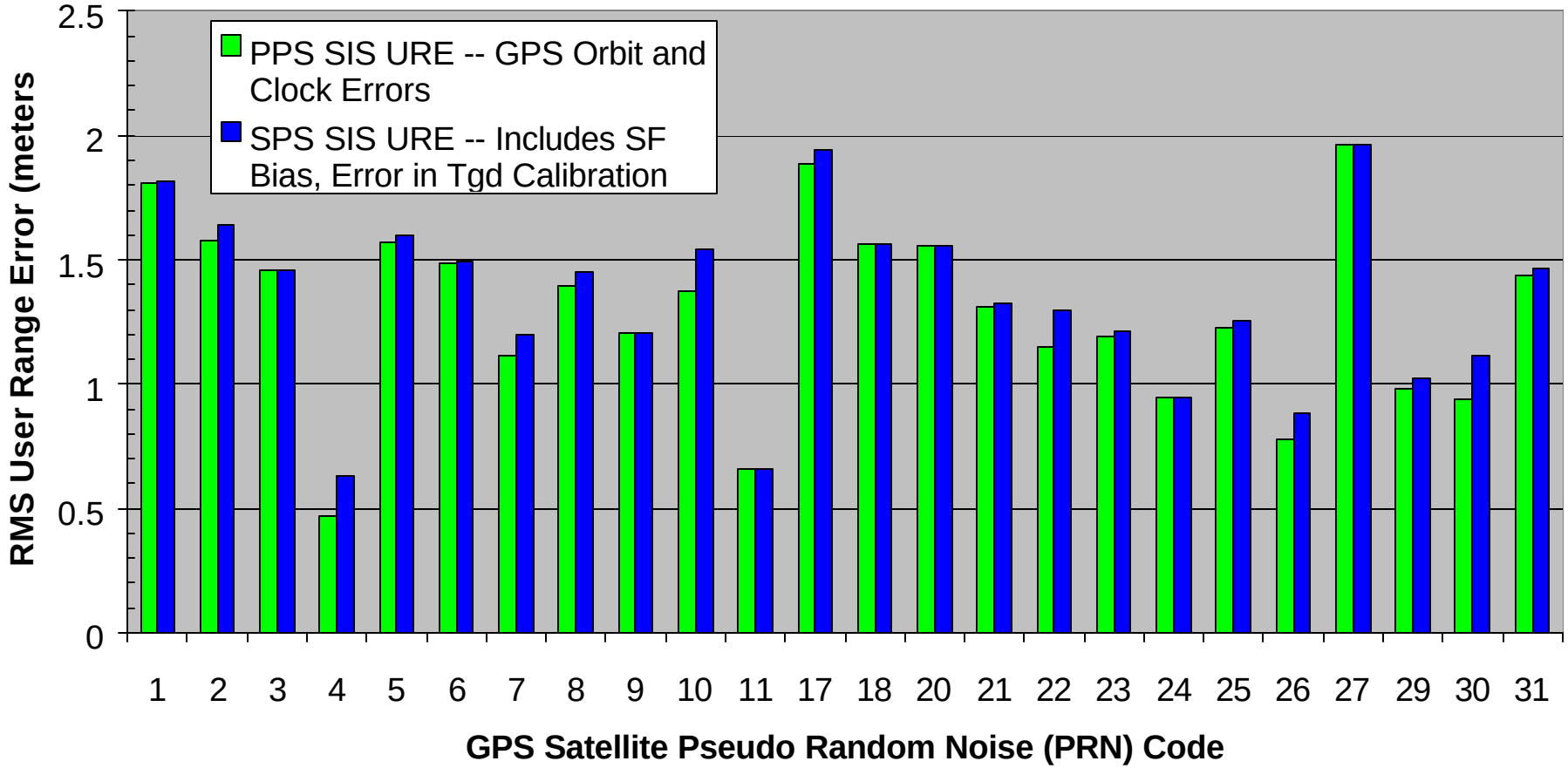


Upload Ops Tempo Assessment

GPS PRN	Average Daily RMS ERD	Average # Uploads/Day	0 Uploads/ Day	1 Upload/ Day	2 Uploads/ Day	3 Uploads/ Day	4 Uploads/ Day	5 Uploads/ Day
1	1.84 m	1.5	0%	53%	47%	0%	0%	0%
2	1.62 m	1.4	0%	67%	30%	3%	0%	0%
3	1.64 m	1.2	0%	83%	17%	0%	0%	0%
4	0.80 m	1.1	3%	83%	13%	0%	0%	0%
5	1.67 m	1.3	0%	70%	30%	0%	0%	0%
6	1.74 m	1.3	0%	67%	33%	0%	0%	0%
7	1.21 m	1.0	0%	97%	3%	0%	0%	0%
8	1.71 m	1.3	0%	73%	23%	3%	0%	0%
9	1.24 m	1.0	7%	90%	3%	0%	0%	0%
10	1.71 m	1.3	0%	73%	27%	0%	0%	0%
11	0.85 m	1.0	3%	93%	3%	0%	0%	0%
13	0.85 m	1.1	3%	83%	10%	3%	0%	0%
15	1.76 m	1.3	0%	73%	20%	7%	0%	0%
16	2.04 m	1.6	0%	53%	40%	3%	0%	0%
17	2.13 m	1.8	0%	37%	47%	17%	0%	0%
18	2.19 m	1.5	0%	53%	27%	13%	0%	0%
19	2.06 m	2.0	0%	39%	43%	21%	4%	0%
20	1.65 m	1.3	0%	87%	3%	7%	3%	0%
21	1.76 m	1.6	0%	53%	37%	10%	0%	0%
22	1.42 m	1.3	0%	87%	7%	3%	0%	3%
23	1.55 m	1.3	0%	73%	23%	3%	0%	0%
24	1.21 m	1.1	0%	87%	13%	0%	0%	0%
25	1.54 m	1.1	0%	93%	7%	0%	0%	0%
26	0.74 m	1.0	0%	97%	3%	0%	0%	0%
27	2.17 m	1.6	0%	53%	37%	10%	0%	0%
29	1.33 m	1.0	0%	100%	0%	0%	0%	0%
30	1.07 m	1.1	0%	90%	10%	0%	0%	0%
31	1.88 m	1.4	0%	60%	37%	3%	0%	0%
Constellation Average	1.54 m	**1.3 uploads/day per satellite**	0.6%	73.9%	21.2%	3.9%	0.2%	0.1%

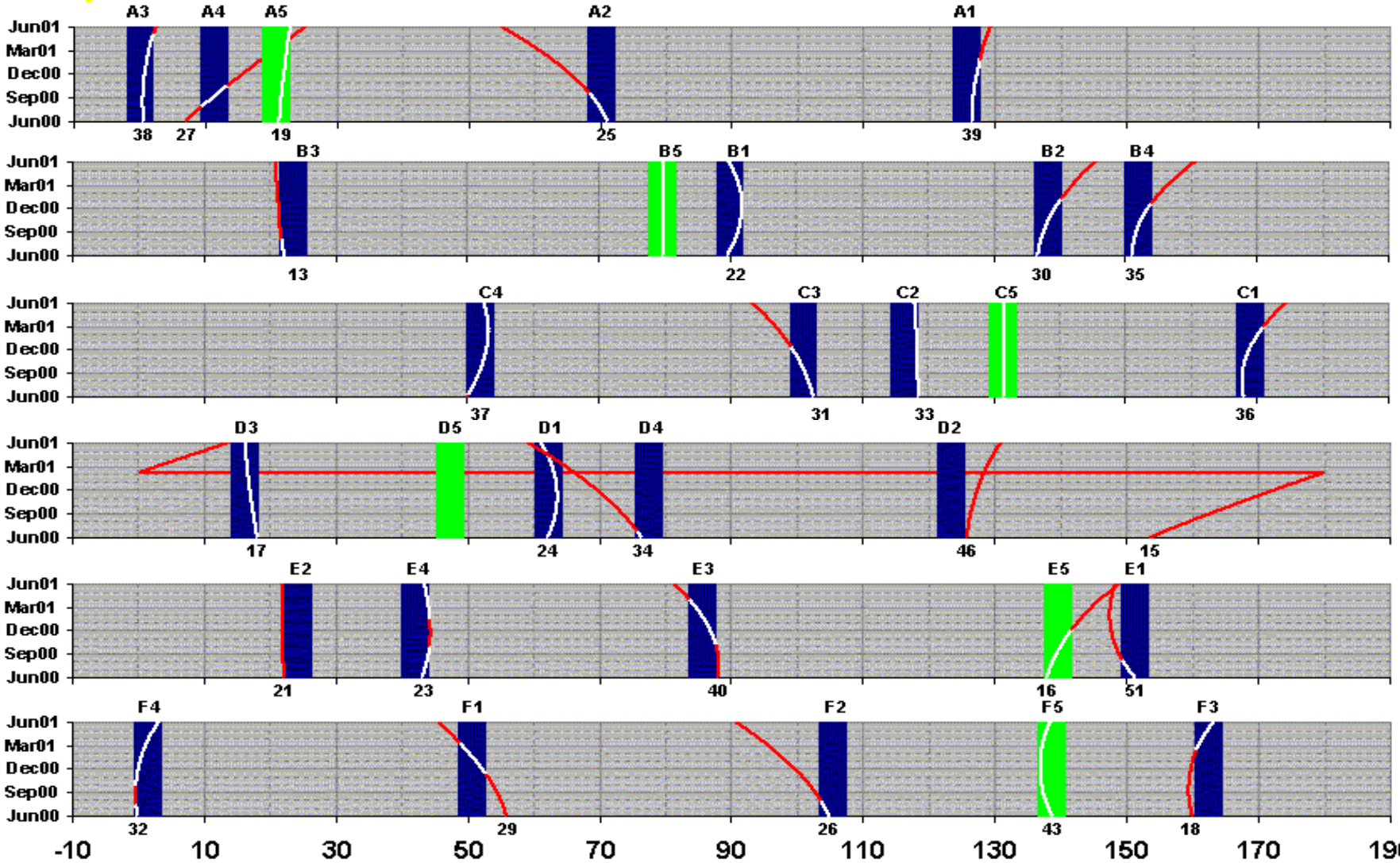
SPS vs. PPS SIS UREs

GPS Satellite UREs -- 10-17 June 2000



Constellation Slot Tolerances

Chart Courtesy 2 SOPS



Constellation Slot Availability

- GPS performance defined conservatively in terms of **primary 24 slot locations**, with ± 2° margin as shown
- Primary slot availability can be no greater than average satellite availability from technical baseline definition
- Slot availability also includes effects of ops policies concerning satellite end-of-life and replacement
- Current policy is to move older satellites out of primary slots if possible, replace with newer satellites in plane
- If primary slot failure occurs, current replacement timelines are **30 days** for in-plane spare, **90 days** for launch call-up
- Directed to use **minimum 22 SVs** in primary slots for margin

OCS Loading Assessment

Routine GPS Constellation Contact Requirements

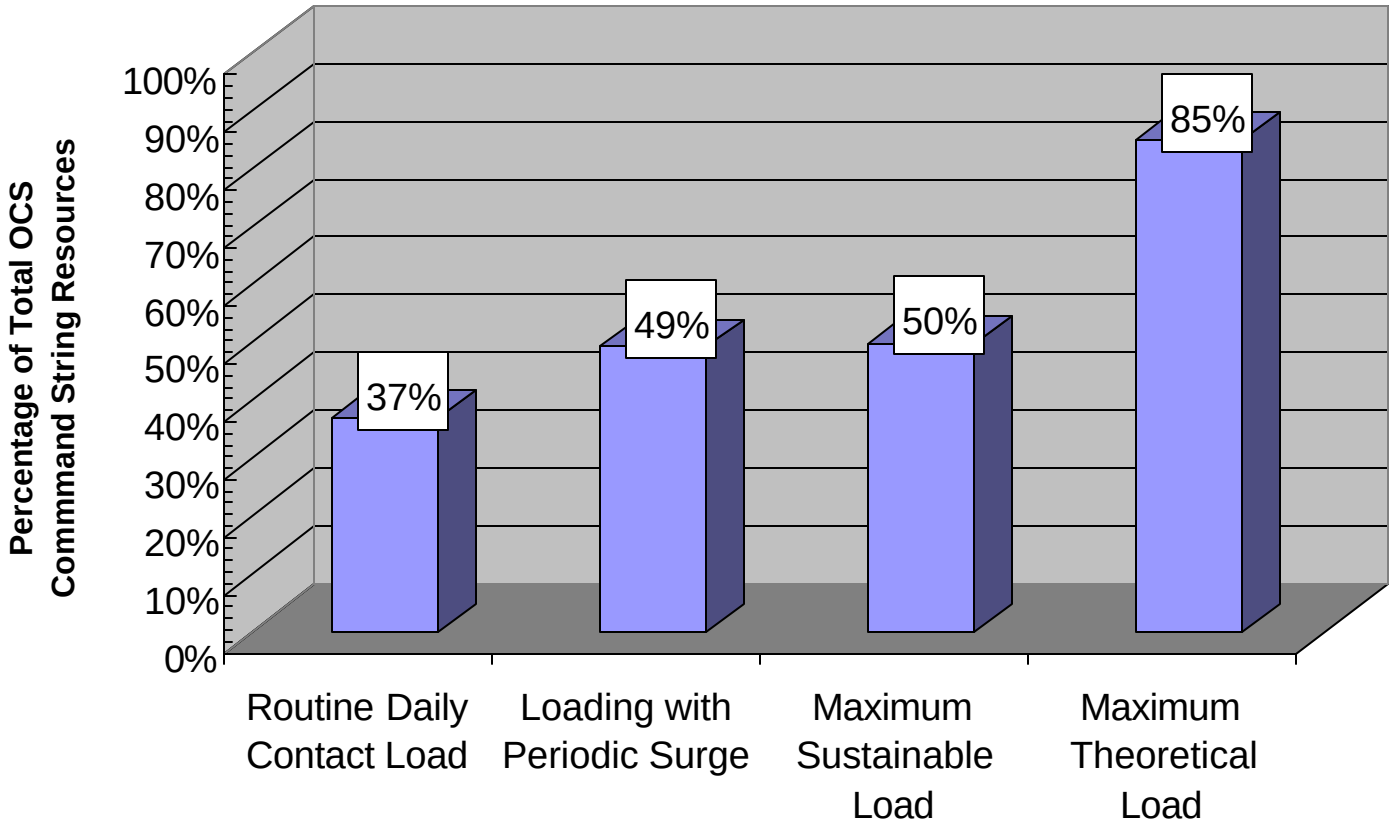
- SOH/NAV Uploads with 3 meter ERD Threshold
- SOH/GBD Dumps
- Eclipse Supports
- Special Supports (Sick & End of Life Satellites)

Periodic Surge Contact Requirements

- Routine Satellite Maintenance Contacts
- Station Keeping Maneuvers
- Program Loads
- Anomaly Supports

OCS Resource Downtime

- PMIs IAW Maintenance Plan
- Mean Time to Repair



- **Maximum Sustainable Load:** Current Scheduling Tolerances and Protocols, OCS Resource Mission Effectiveness and I/O Constraints
- **Maximum Theoretical Load:** Perfect Scheduling with no Conflicts, no Dynamic Rescheduling and no I/O Constraints

Dynamics of Baseline Interactions

SATELLITE REPLACEMENT POLICIES

Disposal Criteria

Replacement Timeline

LIMITING FACTORS

- System Design Characteristics
- O&S Funding
- Current and Projected Personnel (UMD)
- Support Contracts Status
- Modernization Impacts

- SV RMA Characteristics
- SV Orbit Slot Stability
- SV Orbit & Clock Predictability
- OCS State Estimate/Predict Efficiency
- OCS Component RMA Characteristics

CONSTELLATION OPERATIONS

- Daily Satellite Operations
- Planning & Scheduling
- Monitoring, Trending & Reporting
- Training & STANEVAL
- OCS Maintenance & Logistics

- SV Downtime Management Policies
- SV Stationkeeping Maneuver Policies
- SV Failure Contingency Plans
- ERD Tolerances and Contingency Upload Policies
- GPS Timescale Management Policies

PERFORMANCE CONTROLS

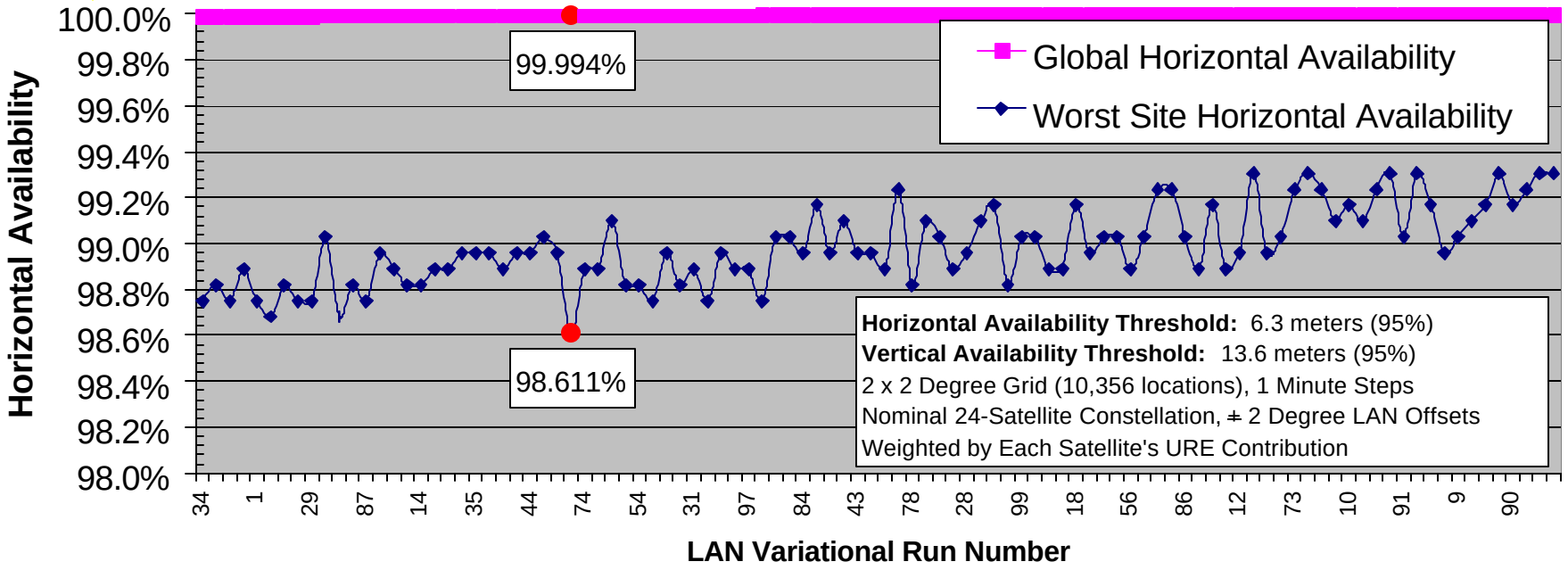
- Satellite Availability Management
- Constellation Slot Management
- Satellite URE Performance Management
- GPS-UTC Time Management

ANALYSIS RESULTS

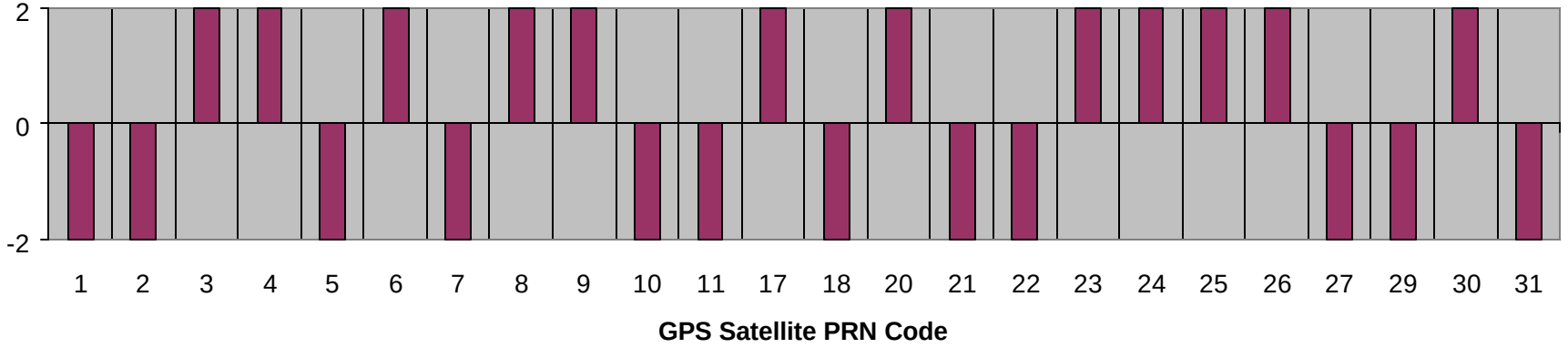
- Service Availability
- Positioning Accuracy
- Definition of the Performance Envelope
- Proposed New Standards

Availability Impact - LAN Variation

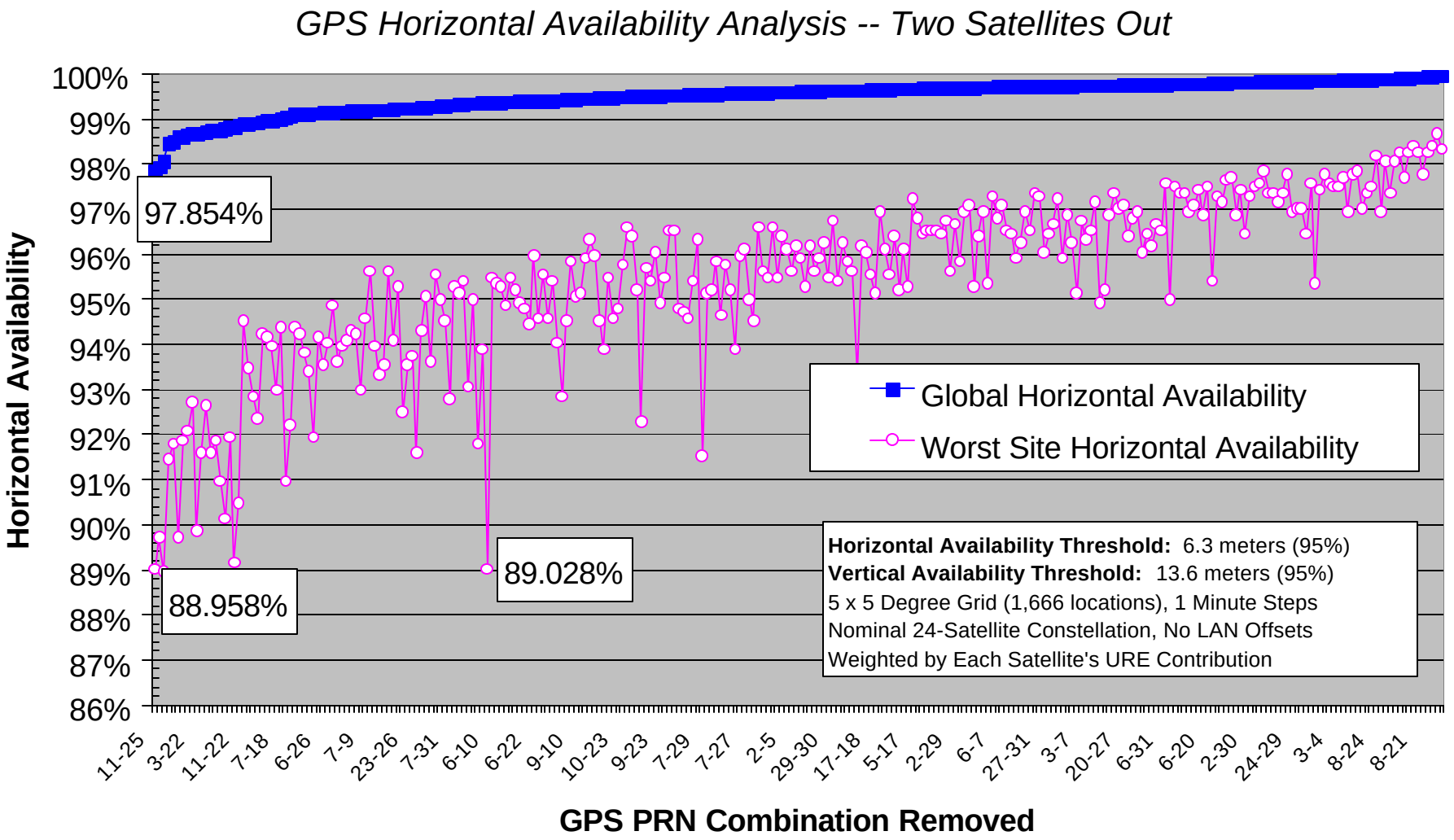
Horizontal Availability as Function of LAN Variation



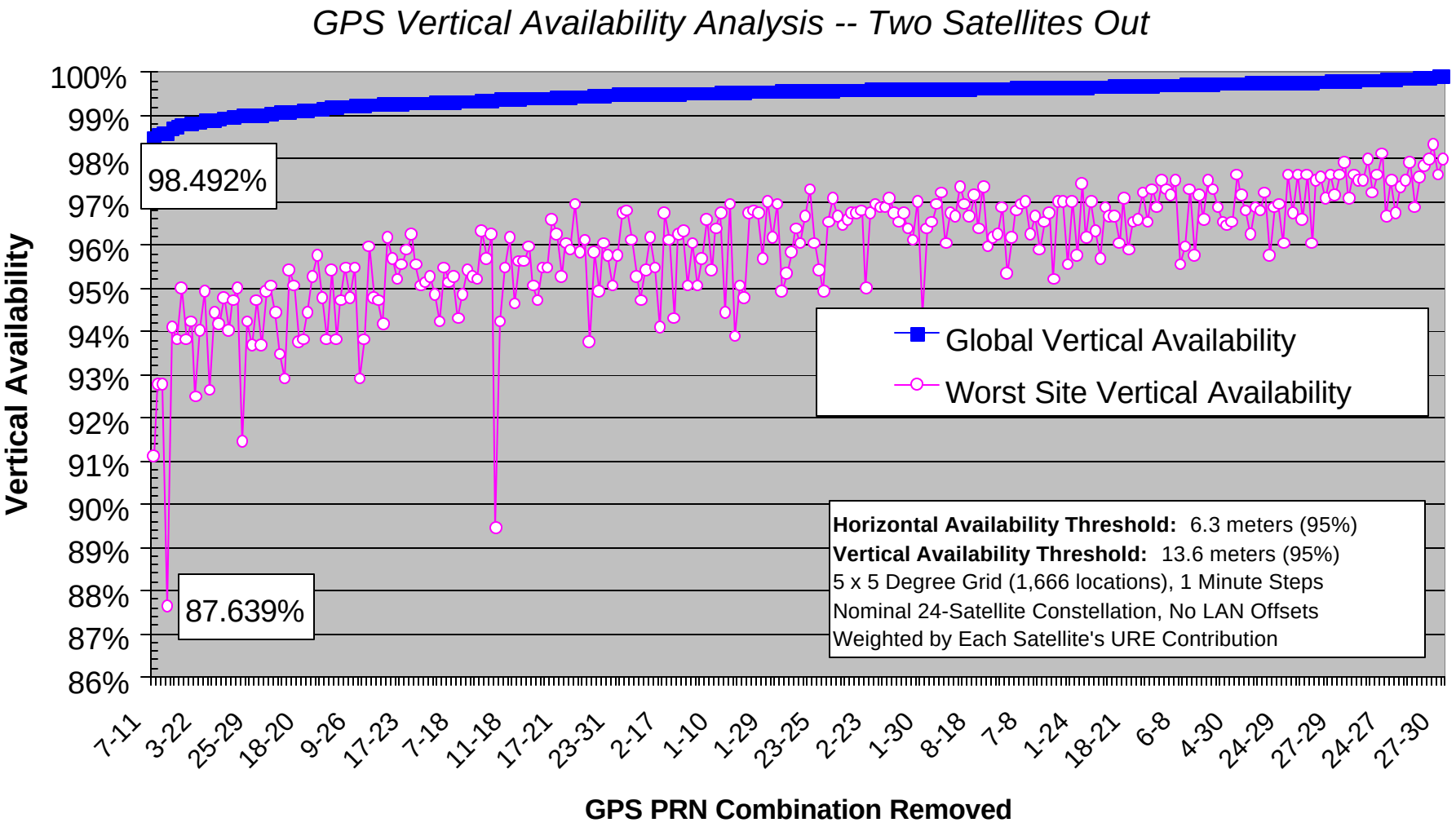
LAN Offset from Nominal Slot for Worst-Case Site Horizontal Availability



Availability Impact -- Two SVs Out



Availability Impact -- Two SVs Out



Availability Impact -- Outage Time

- Satellite maintenance timeline tolerance reduced from 24 hours to 12 hours
- Modest effect on worst site, more significant % in global

Performance Parameter	Variational Parameter	Grid Spacing	Initial Conditions	Run Results				
				Outage Times	Worst Global Horizontal	Worst Site Horizontal	Worst Global Vertical	Worst Site Vertical
Service Availability	Two SVs Out, SIS Outage Times Sensitivity	5x5 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • No SPS biases • Horizontal threshold 6.3 m 95% • Vertical threshold 13.6 m 95%	0000Z to 1159Z	98.921% (11 & 25)	89.375% (11 & 25)	99.234% (7 & 11)	87.639% (11 & 25)
				1200Z to 2359Z	98.928% (11 & 25)	89.167% (9 & 26)	99.240% (7 & 11)	87.847% (11 & 25)

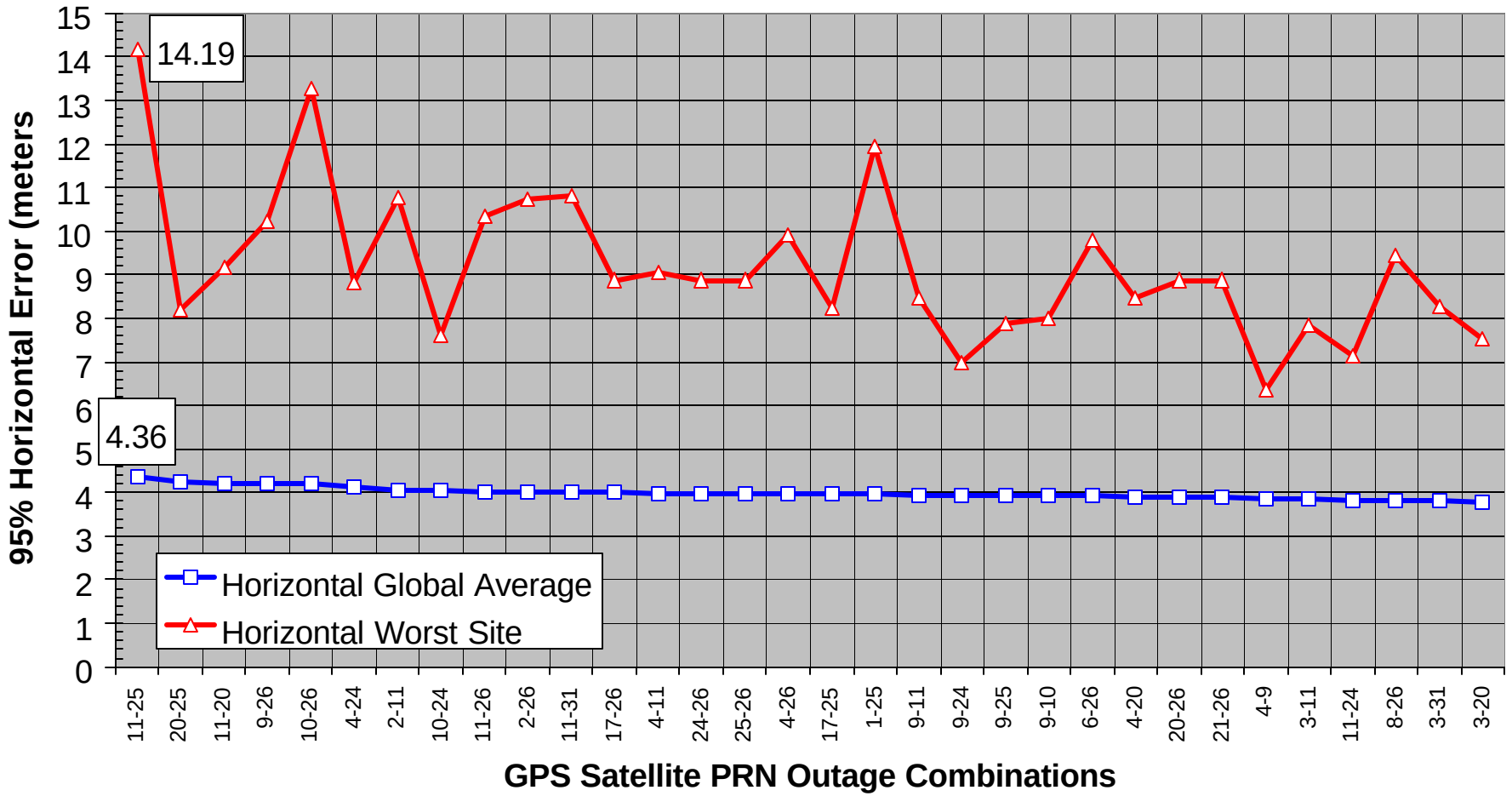
Availability -- Slot Bias + Worst Two SVs

- Combination worst two satellites removed + worst LAN offsets
- Again, modest effect on worst site, more significant % in global

Performance Parameter	Variational Parameter	Grid Spacing	Initial Conditions	Run Results		
Service Availability	Worst Two SVs Out (11-25) + Worst H∆LAN Combination SPS SIS	2x2 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • C/A-P biases • No Iono, Tropo	**Availability Statistic**	**Global Average**	**Worst Site**
				SPS Horizontal Availability 6.3 meters 95%	97.826%	89.931%
				SPS Vertical Availability 13.6 meters 95%	98.583%	88.611%
Service Availability	Worst Two SVs Out (11-25) + Worst V∆LAN Combination SPS SIS	2x2 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • C/A-P biases • No Iono, Tropo	**Availability Statistic**	**Global Average**	**Worst Site**
				SPS Horizontal Availability 6.3 meters 95%	97.097%	87.778%
				SPS Vertical Availability 13.6 meters 95%	98.106%	86.944%

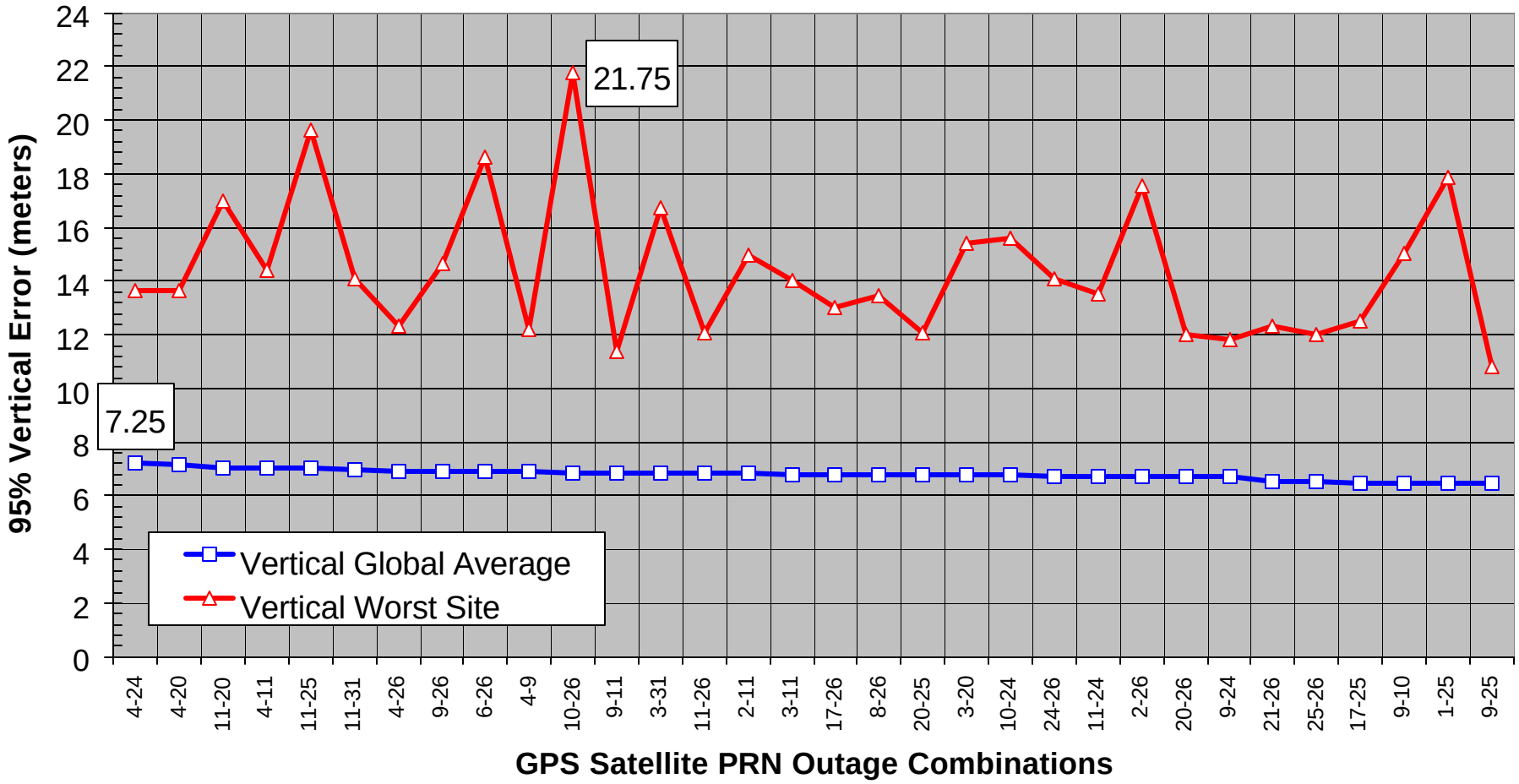
Accuracy Impact -- Two SVs Out

Worst Two-Satellite Outage Combinations for SPS Global Horizontal Error



Accuracy Impact -- Two SVs Out

Worst Two-Satellite Outage Combinations for SPS Global Vertical Error

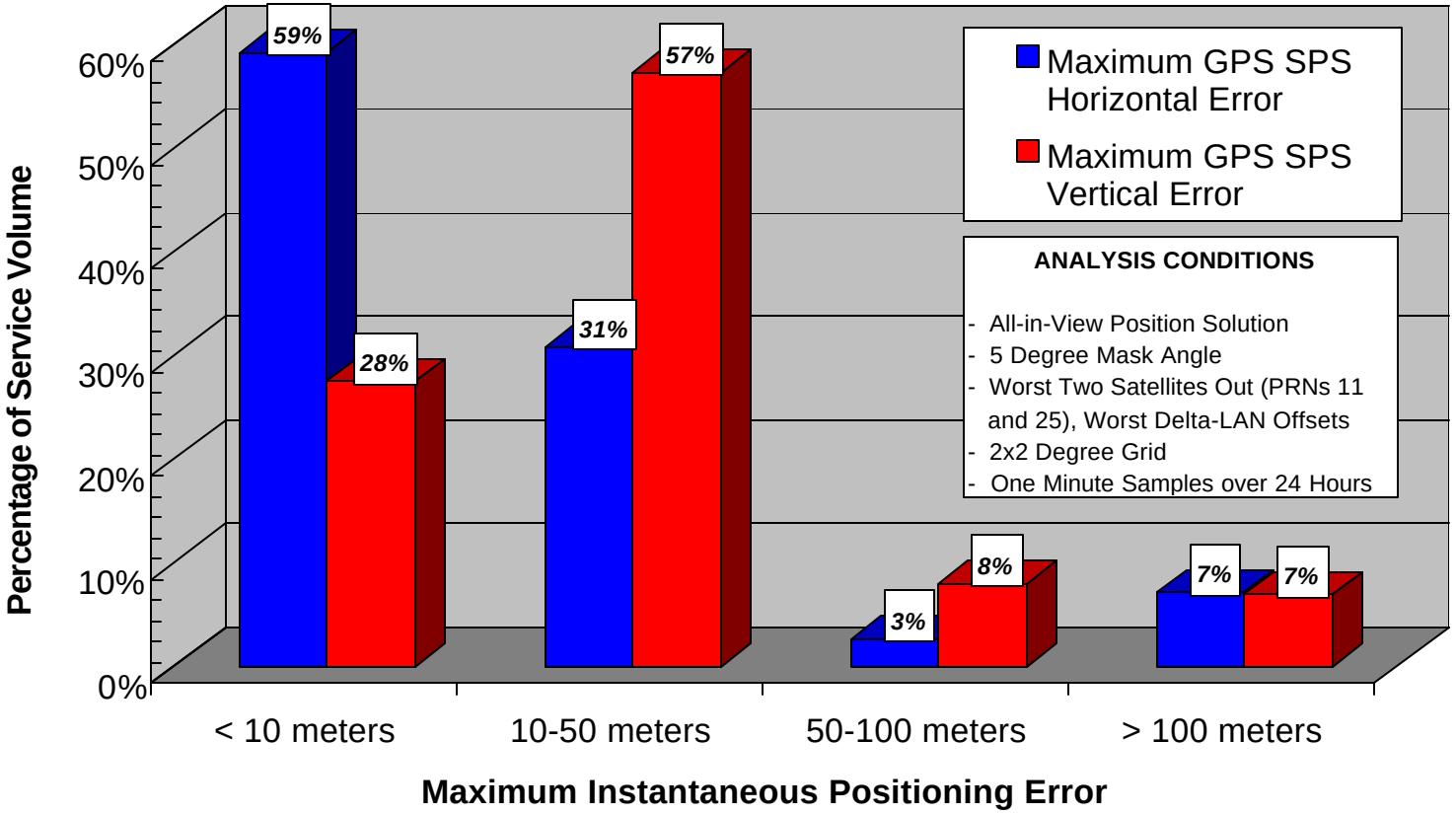


Accuracy -- Slot Bias + Worst Two SVs

- Combination worst two satellites removed + worst LAN offsets
- Modest effect on global and worst site accuracy values

Performance Parameter	Variational Parameter	Grid Spacing	Initial Conditions	Run Results		
				Position Error Statistic	**Global Average**	**Worst Site**
Accuracy	Worst Two SVs Out (11-25) + Worst HΔLAN Combination SPS SIS	2x2 10,356 Points	• 19 June 2000 • No receiver noise • C/A-P biases • No Iono, Tropo	SPS 50% Horizontal	1.7 m	2.5 m
				SPS 95% Horizontal	**4.4 m**	**14.1 m**
				SPS 50% Vertical	2.1 m	3.9 m
				SPS 95% Vertical	7.1 m	23.1 m
Accuracy	Worst Two SVs Out (11&25) + Worst VΔLAN Combination SPS SIS	2x2 10,356 Points	• 19 June 2000 • No receiver noise • C/A-P biases • No Iono, Tropo	**Position Error Statistic**	**Global Average**	**Worst Site**
				SPS 50% Horizontal	1.7 m	2.5 m
				SPS 95% Horizontal	4.4 m	13.2 m
				SPS 50% Vertical	2.1 m	3.7 m
				SPS 95% Vertical	**7.1 m**	**25.3 m**

Outer Limits of GPS Performance



Percentage of Sites < 4 SVs:	11% Globally
Maximum Minutes < 4 SVs:	27 Minutes Worst Site
Average Minutes < 4 SVs:	6.9 Minutes Given Site has Time with < 4 SVs

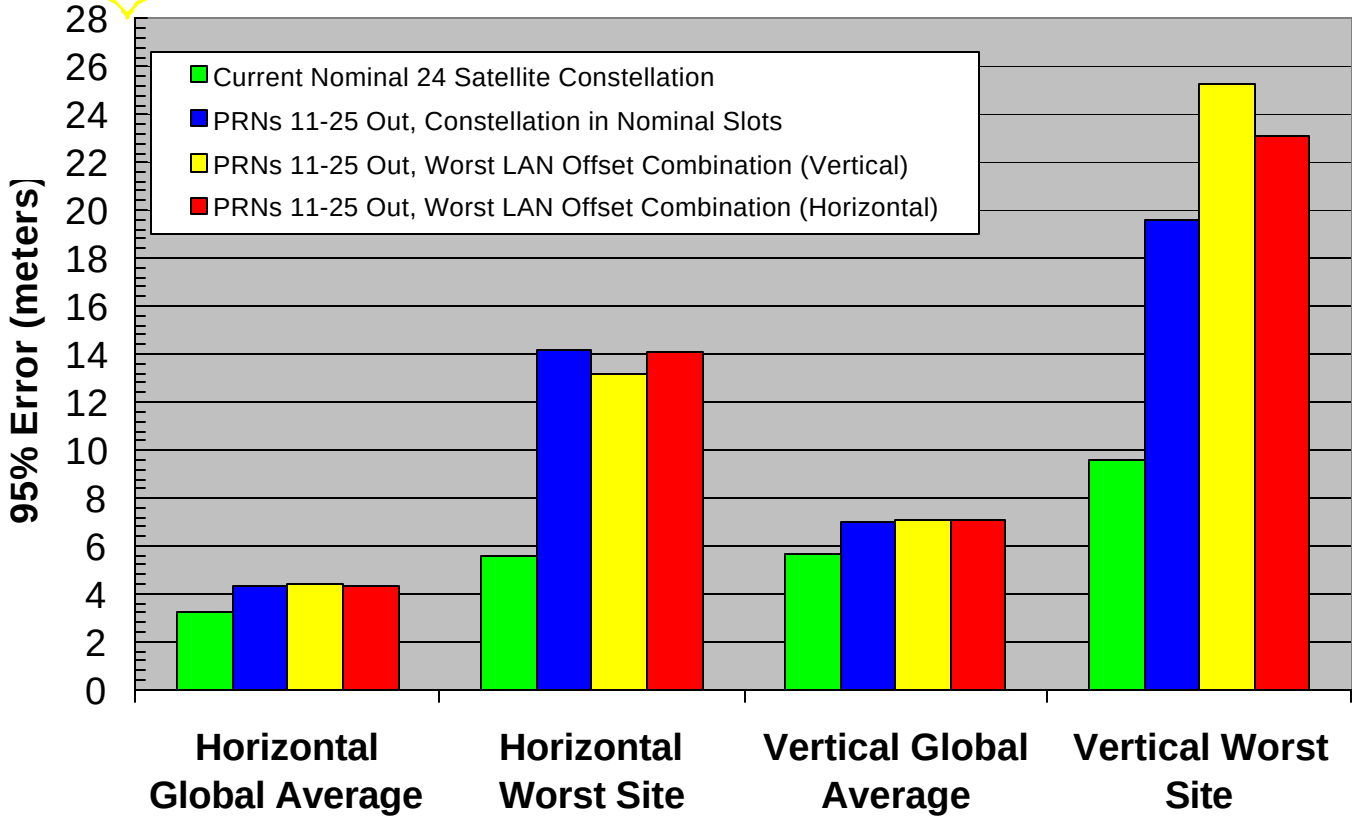
Service Availability Envelope

Service Availability	Worst Two SVs Out (Horizontal, SV 11 & 25 out), **PPS SIS** Threshold Sensitivity	2x2 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • No SPS biases	**Horizontal**	**Global/Worst**	**Vertical**	**Global/Worst**
				6 m 95%	97.53%/88.19%	13 m 95%	98.42%/87.01%
				7 m 95%	98.33%/90.35%	15 m 95%	98.82%/88.33%
				8 m 95%	98.81%/91.60%	17 m 95%	99.05%/89.58%
				9 m 95%	99.07%/92.15%	19 m 95%	99.26%/90.49%
				10 m 95%	99.23%/92.50%	21 m 95%	99.44%/91.18%
Service Availability	Worst Two SVs Out (Vertical, SV 11 & 25 out), **SPS SIS** Threshold Sensitivity	2x2 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • C/A-P biases • No Iono. Tropo	**Horizontal**	**Global/Worst**	**Vertical**	**Global/Worst**
				6 m 95%	97.14% / 87.57%	13 m 95%	98.17% / 86.67%
				7 m 95%	98.11% / 89.79%	15 m 95%	98.71% / 88.13%
				8 m 95%	98.64% / 91.32%	17 m 95%	98.97% / 89.24%
				9 m 95%	98.96% / 91.88%	19 m 95%	99.19% / 90.21%
				10 m 95%	99.16% / 92.36%	21 m 95%	99.38% / 90.97%
Service Availability	Worst Two SVs Out (Vertical, SV 7 & 11 out), **PPS SIS** Threshold Sensitivity	2x2 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • No SPS biases	**Horizontal**	**Global/Worst**	**Vertical**	**Global/Worst**
				6 m 95%	97.72%/89.58%	13 m 95%	98.29%/90.63%
				7 m 95%	98.29%/90.21%	15 m 95%	98.80%/91.67%
				8 m 95%	98.67%/91.11%	17 m 95%	99.08%/92.57%
				9 m 95%	98.93%/92.57%	19 m 95%	99.24%/93.68%
				10 m 95%	99.12%/93.68%	21 m 95%	99.37%/95.07%
Service Availability	Worst Two SVs Out (Vertical, SV 7 & 11 out), **SPS SIS** Threshold Sensitivity	2x2 10,356 Points	• 10-17 June 2000 UREs • No receiver noise • C/A-P biases • No Iono. Tropo	**Horizontal**	**Global/Worst**	**Vertical**	**Global/Worst**
				6 m 95%	97.49% / 89.44%	13 m 95%	98.07% / 90.07%
				7 m 95%	98.15% / 90.07%	15 m 95%	98.67% / 91.32%
				8 m 95%	98.56% / 90.63%	17 m 95%	98.99% / 92.36%
				9 m 95%	98.84% / 91.60%	19 m 95%	99.18% / 93.33%
				10 m 95%	99.05% / 93.26%	21 m 95%	99.31% / 94.79%

Service Availability with Thresholds consistent with Worst Site Accuracy

Horizontal Threshold: 15 meters 95% Vertical Threshold: 26 meters 95%	**Horizontal Availability**		**Vertical Availability**	
	Global Average	Worst Site	Global Average	Worst Site
PRNs 11 & 25 Removed	99.598%	93.958%	99.612%	92.222%
PRNs 7 & 11 Removed	99.543%	96.042%	99.518%	95.694%

SPS Accuracy Envelope



ANALYSIS NOTES

- All-in-view navigation solutions
  - -- 5 degree mask angle
  - -- Sample Rate: Every minute
  - -- Sample Interval: 24 hours
  - -- 2x2 Degree Global Grid
- SPS Signal-in-Space, including noise in Tgd and individual SV C/A-P(Y) biases
- No receiver noise, tropo, or iono effects
- LAN Offset: ± 2 degrees for each satellite, with worst selected from 200 samples
- SV outage combination selected based on assessment of all 274 combinations of two SVs out

Global Average Accuracy

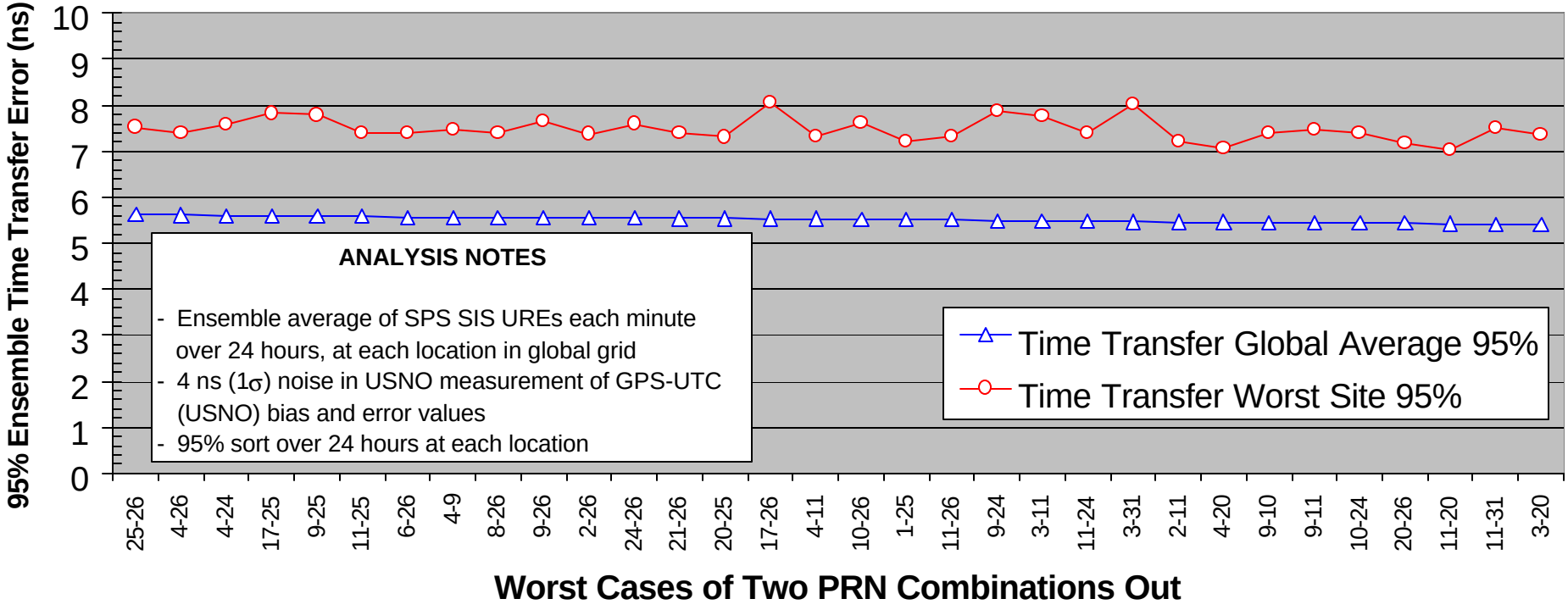
Horizontal 95%: < 5 meters
Vertical 95%: < 8 meters

Worst Site Accuracy

Horizontal 95%: < 15 meters
Vertical 95%: < 26 meters

Ensemble Time Transfer Envelope

GPS SPS All-in-View Ensemble Time Transfer Performance



- ***Worst Case Global Average Time Transfer User Performance:*** 5.6 nanoseconds (95%)
- ***Worst Case Worst Site Time Transfer User Performance:*** 8.1 nanoseconds (95%)

Proposed New Standards -- SPS

SPS Accuracy	Global Average Accuracy	Worst Site Accuracy
Horizontal	5 meters 95%	15 meters 95%
Vertical	8 meters 95%	26 meters 95%

SPS Availability	Global Availability	Worst Site Availability
Horizontal	99.5% at 15 m 95%	92% at 15 m 95%
Vertical	99.5% at 26 m 95%	92% at 26 m 95%

SPS Time Transfer Accuracy: 10 - 20 nanoseconds 95%, Worst Site

NOTES: Position Solution is All-in-View, 5° Mask Angle
SPS SIS Only, does not include Iono, Tropo, Receiver Noise
Time Transfer is All-in-View Residual Averaging

Proposed New Standards -- PPS

- Employ same standards as SPS for routine daily operations
- In addition to routine global ops, provide additional layer of service for CINC-designated Areas of Operations (AOOs)
- PPS performance within AOO driven by weapon systems of concern to area CINC, put in the context of a balance with other targeting and weaponeering error sources